

REMARKS

Applicants are amending their claims in order to further clarify the definition of various aspects of the present invention. Specifically, Applicants have amended claim 4 to recite that the molar ratio is 0.1 to "9", consistent with the description in the paragraph bridging pages 8 and 9 of Applicant's specification, especially on page 8, lines 18-20.

In addition, Applicants are adding new claims 11-21 to the application. Claims 11, 14, 15 and 16 define a molecular weight of the compounds represented by the formulas (1), (2) and (3), consistent with the description in the first full paragraph on page 5 of Applicants' specification. Claims 12 and 17 define the number of carbon atoms in AO, consistent with the description in the second paragraph on page 6 of Applicants' specification; and claims 13 and 19 further define average degrees of polymerization of  $\ell$ , m, n, p, q, r,  $\alpha$ ,  $\beta$  and  $\gamma$ , consistent with the description in the first two full paragraphs on page 7 of Applicants' specification. Claim 18, dependent on claim 3, recites that all of  $Z_4$ ,  $Z_5$  and  $Z_6$  are organic groups having an acryloyl group or a methacryloyl group, consistent with the description in the fourth full paragraph on page 6 of Applicants' specification; and claims 20 and 21, dependent respectively on claims 4 and 20, further define the molar ratio, consistent with the description in the paragraph bridging pages 8 and 9 of Applicants' specification.

Applicants respectfully submit that all of the claims presented for consideration by the Examiner patentably distinguish over the teachings of the prior art applied by the Examiner in rejecting claims in the Office Action mailed December 4, 2006, that is, the teachings of U.S. Patent No. 6,833,220 to Yokoyama, et al, European Patent Application No. EP1 160 268 (Nishiura, et

al), International (PCT) Publication No. WO 03/031453, and Japanese Patent Document No. 2002-348323, under the provisions of 35 U.S.C. §102 and 35 U.S.C. §103.

It is respectfully submitted that these references as applied by the Examiner would have neither taught nor would have suggested such a lithium secondary battery as in the present claims, including, inter alia, an electrolyte containing an ion conductive material and an electrolytic salt, and wherein the ion conductive material contains a boron-containing compound represented by the formula (1) in claim 1, with, inter alia  $\ell$ ,  $m$  and  $n$  of this formula (1) each representing an average degree of polymerization of the oxyalkylene group and is more than 0 and less than 4, provided that  $\ell + m + n$  is one or more. See claim 1.

Furthermore, it is respectfully submitted that these references would have neither taught nor would have suggested such a lithium secondary battery as in the present claims, having, inter alia, the electrolyte containing an ion conductive material and an electrolytic salt, and wherein the ion conductive material comprises a polymerizable composition which contains boron-containing compounds respectively represented by the formula (2) and the formula (3), as in claim 3, and wherein  $p$ ,  $q$ ,  $r$ ,  $\alpha$ ,  $\beta$  and  $\gamma$  of the formulas (2) and (3) each represent an average degree of polymerization of the oxyalkylene group and is more than 0 and less than 4, provided that each of the sum of  $p + q + r$  and the sum of  $\alpha + \beta + \gamma$  is one or more. See claim 3.

In addition, it is respectfully submitted that these applied references would have neither taught nor would have suggested such lithium secondary battery as in the present claims, including the compounds of the formula (2)

and of the formula (3), and wherein these compounds are included in a molar ratio of the compound of formula (2) to the compound of the formula (3) of 0.1 - 9 (see claim 4); more specifically, 0.5 - 4 (see claim 20), even more specifically 1 - 2.5 (see claim 21).

Furthermore, it is respectfully submitted that these applied references would have neither taught nor would have suggested such a lithium secondary battery as in the present claims, having features as discussed previously in connection with claims 1 and 3, and, moreover, wherein the electrolyte contains a polymer obtained by polymerizing the boron-containing compound of the formula (1) (see claim 2), or contains a polymer obtained by polymerizing the polymerizable composition recited in claim 3 (note claims 5 and 6); and/or the further definition of  $\ell$ , m, n, p, q, r,  $\alpha$ ,  $\beta$  and  $\gamma$ , as in claims 13 and 19; and/or molecular weights of the compounds of the formulas (1), (2) and (3), as in claims 11, 14, 15 and 16; and/or number of carbon atoms in AO, as in claims 12 and 17; and/or wherein all of  $Z_4$ ,  $Z_5$ , and  $Z_6$  are organic groups having an acryloyl group or a methacryloyl group (see claim 18); and/or electrolytic salt included with the ion conductive material discussed previously, and in claims 7-10.

The present invention is directed to a lithium secondary battery. Recently, there have been proposed secondary batteries utilizing solid electrolytes, including organic polymers. Organic polymers are generally superior in processability and moldability as compared to other solid electrolytes, e.g., in organic materials, and, as a result, it is expected that organic polymers will be useful in lithium secondary batteries.

However, a defect in previously proposed organic polymer electrolytes in such secondary batteries is an inferior ionic conductivity. That is, previously proposed polymer electrolytes do not have a value of ionic conductivity (1mS/cm or higher at room temperature) which is required in practice for electrolytes of lithium secondary batteries. See the last full paragraph on page 2 of Applicants' specification. In addition, previously proposed polymer electrolytes have inferior high rate discharge characteristics.

Against this background, Applicants provide an ion conductive material having satisfactory ionic conductivity and good high rate discharge characteristics, yet which can easily be made and has other effective properties for an ionic conductive material of a lithium secondary battery. Specifically, Applicants have found that by utilizing boron-containing compounds as in the present claims, having a relatively small number of oxyalkylene groups (that is, where  $\ell$ , m and n each represent an average degree of polymerization of the oxyalkylene group and are each more than 0 and less than 4; or where p, q, r,  $\alpha$ ,  $\beta$  and  $\gamma$  each represent an average degree of polymerization of the oxyalkylene group and are each more than 0 and less than 4, with the sum of  $\ell$ , m and n, p, q and r, and  $\alpha$ ,  $\beta$  and  $\gamma$  being one or more, objectives of the present invention are achieved; and, in particular, an electrolyte is provided having sufficient ionic conductivity and good high rate discharge characteristics.

As to advantages achieved according to the present invention, having a relatively small amount (number) of oxyalkylene groups, attention is respectfully directed to the Examples and Comparative Examples in the

specification of the above-identified application. Attention is particularly directed to Table 1 on page 16, and Table 2 on page 52, of Applicants' specification. In connection with Comparative Examples 1 and 2, note pages 48-51 of Applicants' specification. It is respectfully submitted that Comparative Example 1 uses a polymerizable boron-containing compound having an average polymerization degree of the oxyalkylene group of 8; and that while this compound in Comparative Example 1 falls within materials in International (PCT) Published Application No. WO 03-031453 and Japanese Patent Document No. 2002-348323, it does not fall within the scope of the present claims in view of the average polymerization degree. It is respectfully submitted that Comparative Example 1 does not attain all of sufficient initial charging capacity, cycle life, high rate discharge characteristics and ionic conductivity as achieved by the present invention.

Attention is also respectfully directed to Comparative Example 2 on pages 50 and 51 of Applicants' specification, evaluating a composition of a polymerizable boron-containing compound J (average polymerization degree of AO: 8) and a polymerizable boron-containing compound K having no polymerizable (group average polymerization degree of AO: 11.8). The molar ratio of compound J to compound K in Comparative Example 2 is 0.79; compare with the molar ratio of claim 4. Thus, while the molar ratio of compound J to compound K falls within the present claims, the average polymerization degree of AO in Comparative Example 2 does not fall within that set forth in the present claims. As can be seen in the results for Comparative Example 2 in Table 2 on page 52, ionic conductivity and high rate discharge characteristics are inferior to that of the present invention.

It is respectfully submitted that this evidence in Applicants' specification must be considered in determining patentability. See In re DeBlauwe, 222 USPQ 191 (CAFC 1984). It is respectfully submitted that this evidence in Applicants' specification clearly establishes, and supports, patentability of the presently claimed subject matter, over the teachings of the applied prior art, as discussed infra.

Nishiura, et al discloses an ion-conductive polymeric compound, a polymeric electrolyte and an electric device using the same. This patent discloses three boron-containing compounds, in paragraphs [0007] - [0011] on pages 3 and 4 of this patent document. A more specific description of the third ion-conductive polymeric compound is set forth in paragraph [0035] on page 6 of this patent document, the compound being obtained by polymerizing a mixture of compounds represented by general formulas (9) and (10) in paragraphs [0035] - [0043] on pages 6-9 of this patent document. The Examiner has specifically referred to Compound A-1 shown in paragraph [0104] on page 16 of the patent document.

Insofar as Nishiura, et al, is applicable to present claims 1, 2, 7 and 8, it is respectfully submitted that this patent document would have neither disclosed nor would have suggested the presently claimed ion conductive material including, inter alia, wherein the average polymerization degree of AO is more than 0 and less than 4, as in claim 1, and/or more specific definition in claim 13. Moreover, it is respectfully submitted that the compound of Nishiura, et al, would fail to achieve advantages of the present invention, that is, enhancement of ionic conductivity, achieved, inter alia,

through use of compounds having average polymerization degree of AO of more than 0 and less than 4.

Clearly, Nishiura, et al, would not have anticipated the presently claimed subject matter, including the average degree of polymerization of the oxyalkylene groups, and would not have taught nor would have suggested the advantages achieved due thereto.

Japanese Patent Document 2002-348323 discloses a polymerizable borate compound useful as a material for electrochemical devices such as a secondary battery, obtained by esterification of a polymerizable compound represented by formula (1) (that is,  $XO(AO)_nH$ , wherein X is an acryloyl group or methacryloyl group, AO is a two-four carbon oxyalkylene group and n = 1 - 100) with boric acid or boric acid anhydride.

No. WO 03/031453 discloses a process for producing a boric ester compound which comprises reacting a compound represented by the formula (1) ( $X - [0(AO)_nH]_a$ , X being a group independently selected among a residue of a compound having 1-6 hydroxy groups, acryloyl and methacryloyl) with a boron compound represented by the formula (2) ( $((RO)_3B$ , where R is  $C_{1-4}$  alkyl) to produce the boric ester compound. Also disclosed are polymer electrolytes containing the boric ester compound

As seen in the foregoing, as well as from full reviews of each of the published Japanese patent document and International published application, it is respectfully submitted that these documents would have neither taught nor would have suggested the presently claimed invention, including average degree of polymerization of the oxyalkylene group, and advantages achieved

due thereto, including, e.g., ionic conductivity and high rate discharge characteristics.

In particular, note Examples 1-30 of the present application, the results of which are shown in Table 2 on page 52 of the specification. Results for Comparative Examples 1 and 2 are also shown in this Table 2. For evaluating high rate discharge characteristics, discharge characteristics are tested at high current density conditions. Polyelectrolytes conventionally used have low ionic conductivity and hence are insufficient in high rate discharge characteristics, are important properties for practical use.

In order to obtain all the advantages of the present invention including high rate discharge characteristics, it is important that the average polymerization degree of the oxyalkylene group be more than 0 and less than 4, which is neither disclosed nor suggested, nor is obtained, in No. 2002-348323 or No. WO 03/031453.

In contrast, the present invention, utilizing the ion conductive material as in the present claims, having the recited average degree of polymerization of the oxyalkylene groups, obtains all of sufficient initial discharge capacity, cycle life, high rate discharge characteristics and ionic conductivity. Neither of No. 2002-348323 or No. WO 03/031453 would have disclosed nor would have suggested the presently claimed invention including specific material utilized as the ion conductive material of the electrolyte, and advantages achieved thereby.

U.S. Patent No. 6,833,220 discloses an electrolyte, for secondary batteries, which is a polymer electrolyte, the electrolyte including an ionic compound and an organic polymer compound, the organic polymer

compound comprising a compound represented by the general formula (1) or (2) (see column 2 of the patent) or a polymerization product of a boric acid ester compound obtained by the esterification of the compound represented by the general formula (1) or (2) with boric acid or boric anhydride. Note, in particular, column 2, lines 21-38; and column 2, line 50 through column 3, line 8. See also the paragraph bridging columns 6 and 7 of this patent. The Examiner has also referred to column 34 of this patent, setting forth fully therein claims 2-7 and the first two lines of claim 8, the Examiner referring to a specific formula set forth in claim 4 thereof.

It is respectfully submitted that in No. 6,833,220, all of the boron compound molecules have polymerizable functional groups, so that crosslinking density of the resulting polymer compound becomes high and its elastic modulus is high. In contrast, note that R<sub>1</sub>, R<sub>2</sub> and R<sub>3</sub> in claim 3 each represents a hydrocarbon group of 1-10 carbon atoms. That is, R<sub>1</sub>, R<sub>2</sub> and R<sub>3</sub> are not polymerisable functional groups. It is respectfully submitted that No. 6,833,220 would have neither disclosed nor would have suggested the presently claimed invention, including, inter alia, the compound of the formula (3) and advantages thereof.

Furthermore, note that No. 6,833,220 discloses that the compound can have as many as 600 oxyalkylene groups. It is respectfully submitted that the resulting polymer compound would have poor mobility, and, consequently, ionic conductivity of the polymer compound would be low. It is respectfully submitted that No. 6,833,220 would have neither taught nor would have suggested the degree of polymerization as in the present claims, and advantages thereof.

In summary, it is respectfully submitted that No. 6,833,220 does not disclose, nor would have suggested, the battery as in the present claims, including the ion conductive material having the degree of polymerization of the oxyalkylene group as in all the claims; or having, in addition, the additional compound containing boron atom and without polymerizable functional groups as in the compound of formula (3) in the present claims, and advantages thereof.

Furthermore, note the molecular weight recited in, e.g., claims 11 and 14-16. Such relatively small molecular weight is indicative of a small number of AO groups. It is respectfully submitted that the teachings of the applied references would have neither taught nor would have suggested compounds represented by the formulas (1), (2) and (3) having the specified molecular weight, as the ion conductive material of the electrolyte of the lithium secondary battery of the present claims, and advantage thereof.

Applicants respectfully traverse the non-statutory obviousness-type double patenting rejection of claims 1 and 2, over claims 6, 9, 11 and 13 of U.S. Patent No. 6,998,465.

Initially, note different Assignees of the above-identified application and of U.S. Patent No. 6,998,465.

Moreover, note that U.S. Patent No. 6,998,465 claims a process for producing a boric acid ester compound, and an electrolyte which includes such boric acid ester compound and a secondary battery using such electrolyte. Note especially claims 1 and 7 of No. 6,998,465. It is respectfully submitted that No. 6,998,465 does not disclose, nor would have suggested, such battery as in the present claims including, inter alia, wherein the average

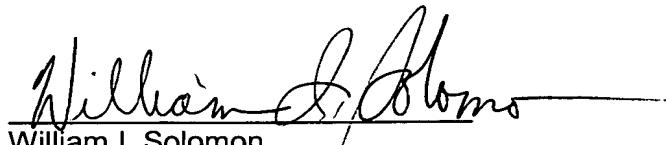
degree of polymerization of the oxyalkylene groups is that set forth in the present claims, and advantages thereof.

It is to be noted that No. 6,998,465 is the U.S. patent corresponding to previously discussed No. WO 03/031453, and it is respectfully submitted that, especially in light of comments made previously in connection with WO 03/031453, the subject matter claimed in No. 6,998,465 would have neither taught nor would have suggested the subject matter of present claims 1 and 2.

In view of the foregoing comments and amendments, reconsideration and allowance of claims presently pending in the above-identified application are respectfully requested.

To the extent necessary, Applicants petition for an extension of time under 37 CFR §1.136. Please charge any shortage in the fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account No. 01-2135 (Case No. 500.42907PX1) and please credit any excess fees to such deposit account.

Respectfully submitted,

  
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Attachments